



LIGHTER-THAN-AIR (LTA) VEHICLES:  
A TECHNICAL BIBLIOGRAPHY

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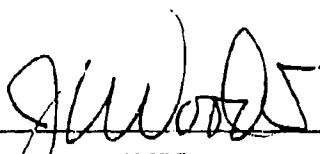
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This technical bibliography provides a systematic accounting of Lighter-Than-Air (LTA) documents. This report should enable rapid review of past and present activities for specific individual applications. Both author and subject indices are included.		

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## I. INTRODUCTION

This document is intended to provide information for the Lighter-Than-Air (LTA) technical community. This bibliography is the result of numerous searches of both old and new literature on this topic since the fall of 1975. These searches have been conducted in support of investigations by the LTA Project Office (605B) at the Naval Air Development Center, Warminster, PA 18974. Hopefully, it will serve to assist the studies of others in this field by presenting in one volume a fairly complete listing of technical reports, papers, memoranda and articles.

The report format is organized to present an alphabetical authors index plus a cross-reference by subject.

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- 173. 89 - Performance of a Nonrigid Airship of 320,000 cu. ft. Volume, Inflated with Helium and Fuel Gas.
- 174. 90 - The Properties of Cold Worked Duralumin.
- 175. 91 - A Discussion of Methods for Providing a View of the Bottom Fin and Rudder from the Control Car of the ZRS-4.
- 176. 92 - Static Bending Moments and Stresses in the U.S.S. LOS ANGELES as Designed and in Service in 1930.
- 177. HOOPER, A. G. 93 - Analysis of Structural Weights and Girder Characteristics of Various Airships.
- 178. 94 - Comparative Strength and Factors of Safety of U.S.S. LOS ANGELES as Designed and in Service in 1930.
- 179. 96 - Water Recovery Apparatus for Airships.
- 180. 97 - Comparison of the Proposed "100 Ton, 100 Mile" Metalclad Airship, and an Equivalent Rigid Airship of Conventional Design.
- 181. 98 - Stress Analysis of a Main Frame of Airship ZRS-4.
- 182. 99 - Analysis of Tests of Longitudinal Girders for Airship ZRS-4.
- 183. 100 - Internal vs. External Engines for Airships.
- 184. 101 - Effect of Slackening Gas Cell Wires on U.S.S. LOS ANGELES.
- 185. 102 - Progress in Airship Design From U.S.S. SHENANDOAH to U.S.S. AKRON.
- 186. 103 - External vs. Internal Radiators for Airships.
- 187. HOOPER, A. G.  
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- 188. 105 - Theory of the Inherently Stiff Ring Frame for Airships.
- 189. 106 - The Strength of Airship Mooring Masts.
- 190. 107 - Methods of Supporting the Bow of an Airship While Mooring to a Mast.
- 191. 108 - Significance of the Tests of the Metal Models of Airships ZRS-4 and MC-38 in the Variable Density Wind Tunnel.

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| 192. | BURGESS, C. P.<br>(Continued) | 109,- Internal Radiators for Airships.  |
| 193. |                               | 110 - Effect of Adding One Main Bay to the ZRS-5.   |
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| 195. |                               | 112 - Comparison of Static Bending Tests of Airships<br>LOS ANGELES and AKRON.                            |
| 196. |                               | 113 - Resistance of a Core Radiator Enclosed in a Duct.   |
| 197. |                               | 114 - Strength of Expeditionary Mooring Masts.  |
| 198. |                               | 115 - Forces on the Airplane Trapeze for U.S.S. AKRON.  |
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| 200. |                               | 117 - Resistance of Mark IV Water Recovery Apparatus.   |
| 201. |                               | 118 - Forces on U.S.S. AKRON During Ground Handling.  |
| 202. |                               | 119 - Analyses of the Goodyear-Zeppelin's Company Pro-<br>posals to Reduce the Drag of the Airship MACON. |
| 203. |                               | 120 - Steam Power Plant for Airships, Proposed by the<br>Great Lakes Aircraft Corporation.                |
| 204. |                               | 121 - Calculation of Stresses in Three Bridle System<br>of Stern Handling Lines for U.S.S. AKRON.         |
| 205. |                               | 122 - Use of Dynamic Lift in the U.S.S. AKRON in Deflated<br>Gas Cell Conditions.                         |
| 206. |                               | 123 - Resistance of the Bare Hull of the U.S.S. AKRON.  |
| 207. |                               | 124 - Note on the Variation of Wind Velocity with Altitude.   |
| 208. |                               | 125 - Air Cooling vs. Water Cooling for Mayback Engine<br>Manifolds.                                      |
| 209. |                               | 126 - Cooling of Airship Radiators by Circulation of<br>Internal Air.                                     |
| 210. |                               | 127 - Stress in a Ring Subjected to Two Opposite Forces.  |
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| 212. |                               | 129.- Comparison of Navy Airship K-1 and Army TC-13.  |
| 213. |                               | 130 - Improvements in Mark IV Water Recovery Apparatus.   |

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| 215. |                               | 132 - The Aerodynamic Control of Airships.   |
| 216. |                               | 133 - Bow Elevators for Airships.  |
| 217. |                               | 134 - Local vs. General Loads on Airship Girders.  |
| 218. |                               | 135 - Comparison of Weights of U.S.S. AKRON and MC-74.   |
| 219. |                               | 136 - Comparison of Least Work and Column Analogy Methods of Stress Analysis.                          |
| 220. |                               | 137 - A Useful Beam and Column Relation.   |
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| 230. |                               | 147 - Reply to Criticism of Metalclad Airship Corp. on Design Memorandum No. 142.                      |
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| 246. |                               | 163 - The Diving Planes of Submarine Vessels.  |
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| 248. |                               | 165 - The Solution of Numerical Simultaneous Equations of the First Degree.                                |
| 249. |                               | 166 - The Analysis of Cantilever Wings in Torsion by the Friedrichs-vonKarman Equations and by Least Work. |
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| 259. |                               | 176 - Performance of 1,200,000 ft. <sup>3</sup> Metalclad Airship.   |
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| 309. |                               | 226 - The Frequencies of Cantilever Wings in Beam<br>and Torsional Vibrations.                          |
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| 317. |                               | 234 - Stability of the Center Spar in a Spar Type Airship.  |
| 318. |                               | 235 - Proposed Airplane Carrier Airship.  |
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| 326. |                | 243 - Comparison of 7.8 Million cu. ft. Airship Proposed by Goodyear-Zeppelin Corp. and U.S.S. MACON. |
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| 330. |                | 247 - Effect of Elastic End Restraints Upon the Frequency of Vibration and Critical Load of Columns.  |
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| 334. |                | 251 - Bending Moment Due to Axial Stress in a Ring.   |
| 335. |                | 252 - Discussion of Airship Structural Model Test by Goodyear Tire & Rubber Co.                       |
| 336. |                | 253 - Analysis of a Centrally Loaded Beam on a Continuous Elastic Support.                            |
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452. 368 - The Endurance of a Free Balloon with Automatic Pressure and Ballast Control:
453. 369 - The Decay of Axial Force in a Uniformly Supported Member.
454. 370 - Torsion of a Box Spar with One Fixed End.
455. 371 - Small, Long Range Spherical Balloons.
456. 372 - Control Forces on Airships.
457. 373 - The Side Panel Wiring of Rigid Airships.
458. 374 - An Observation Airplane for Airships.
459. 375 - Water Mooring Gear for Model ZNPK Airships.
460. 376 - Comparison of Airship and Slow Flying Airplane.
461. 379 - Boundary Layer Control for Airships.
462. 381 - Operating Costs of Transport Airships.
463. 382 - Comparison of BuAer and G.A.C. Estimates of Weights of XZPN Airship.
464. 383 - The Coning and Bending of an Airship Propeller with Hinged Blades.
465. 384 - Resistance vs. Weight in Model XZPN Airship.
466. 385 - Comparative Weights of Models XZPM And XZPN Airships.
467. 386 - Characteristics of Airship Tail Surfaces.
468. 387 - Comparison of Douglas and Goodyear Aircraft Corp. Proposals for Model XZPN Airship.
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470. 389 - The Fuel Required to Transport Fuel.
471. 390 - Increase in Range of Airships by Dynamic Lift at Take-Off.
472. 391 - A Note on Fortisan Rayon Fabric.

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- 475.                                      394 - Calculations for an Apparatus to Distill Three  
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- 476.                                      395 - Weight of Airship ZP2K-93.
- 477.                                      396 - Strength of Airship Seats.
- 478.                                      397 - Comparative Performance of ZPN Airship with Cotton  
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III. SUBJECT CROSS REFERENCE

OUTLINE

A. Requirements

1. Applications/Economics
2. Missions Analysis
3. Specifications

B. Design Considerations

1. Parametric Analysis/Methodology
2. Vehicle Point Designs
3. Technologies
  - a) Aerodynamics
  - b) Aerostatics
  - c) Structures/Materials
  - d) Propulsion
  - e) General
  - f) Stability and Control
  - g) Human Factors
  - h) Support Equipment
  - i) Manufacturing
4. Performance Estimates

C. Fabrication

1. Past
2. Present/Future

D. Test and Evaluation

1. Ground
2. Flight



E. Acceptance Tests

F. Operation

1. Flight Handbooks/Procedures
2. Evaluations
  - a) Vehicle
  - b) Sensors
  - c) Weapons
  - d) Fleet Evaluations
  - e) Support Equipment
3. Mission Performance
  - a) ASW
  - b) AEW
  - c) Other
4. Ground Handling
5. Vulnerability
  - a) Weather
  - b) Hostile Action
6. History
7. Environmental Data/Considerations

G. Costing

LISTING

A. Requirements

1. Applications/Economics:

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908, 914, 915, 916, 917, 918, 946, 950, 951, 952, 954, 968, 969, 970, 971,  
972, 1004, 1019, 1021, 1032, 1033, 1036, 1043, 1044, 1048, 1050, 1052, 1064,  
1071, 1076, 1083, 1084, 1099, 1112, 1115, 1116, 1118, 1120, 1121, 1125,  
1136, 1137, 1150, 1151, 1152, 1179, 1180, 1181, 1182, 1185, 1190, 1196,  
1211, 1220, 1229, 1230, 1245.

A. Requirements (cont)

2. Missions Analysis:

15, 16, 17, 21, 23, 30, 32, 52, 64, 67, 130, 354, 364, 400, 428, 430, 431,  
438, 444, 470, 495, 529, 531, 532, 562, 595, 636, 637, 640, 643, 693, 710,  
713, 808, 809, 810, 813, 816, 833, 844, 851, 859, 860, 872, 876, 877, 907,  
908, 932, 941, 942, 947, 948, 955, 956, 1026, 1035, 1036, 1045, 1046, 1052,  
1053, 1058, 1059, 1102, 1175, 1176, 1177, 1234, 1245.

A. Requirements (cont)

3. Specifications:

66, 80, 81, 82, 84, 276, 277, 346, 523, 1024

B. Design Considerations

1. Parametric Analysis/Methodology:

13, 16, 17, 18, 20, 30, 32, 41, 52, 64, 117, 120, 124, 125, 132, 146, 159,  
202, 280, 338, 340, 358, 359, 398, 422, 432, 463, 470, 471, 524, 530, 533,  
535, 536, 551, 552, 567, 606, 610, 615, 636, 637, 640, 643, 689, 703, 712,  
782, 805, 806, 833, 843, 844, 852, 859, 860, 883, 889, 890, 891, 892, 893,  
894, 895, 897, 920, 926, 927, 932, 934, 935, 936, 947, 948, 956, 1029, 1037,  
1038, 1051, 1054, 1068, 1160, 1173, 1204, 1244.

B. Design Considerations (cont)

2. Vehicle Point Designs:

4, 7, 13, 16, 17, 18, 19, 20, 30, 32, 33, 41, 47, 52, 75, 88, 101, 126, 129,  
146, 171, 173, 180, 185, 272, 281, 318, 319, 326, 341, 351, 357, 360, 364,  
365, 372, 376, 381, 390, 395, 396, 397, 405, 413, 447, 448, 468, 499, 504,  
525, 530, 550, 589, 600, 601, 602, 620, 624, 629, 630, 632, 633, 634, 640,  
643, 650, 652, 653, 658, 659, 663, 720, 721, 726, 732, 754, 763, 765, 813,  
815, 816, 820, 843, 859, 869, 871, 879, 883, 886, 889, 890, 894, 895, 896,  
897, 920, 933, 935, 936, 954, 955, 966, 967, 970, 971, 978, 1016, 1023,  
1034, 1043, 1044, 1045, 1046, 1054, 1055, 1056, 1104, 1127, 1129, 1130,  
1143, 1238.

B. Design Considerations (cont)

3. Technologies:

a) Aerodynamics:

2, 10, 30, 54, 56, 57, 94, 108, 114, 116, 127, 135, 144, 153, 158, 163,  
 191, 200, 202, 205, 206, 215, 216, 223, 252, 261, 263, 271, 279, 283,  
 284, 285, 292, 293, 295, 313, 314, 321, 324, 329, 343, 345, 347, 359,  
 363, 366, 370, 371, 376, 385, 408, 409, 411, 414, 416, 443, 455, 461,  
 465, 467, 473, 485, 498, 503, 512, 519, 525, 528, 534, 542, 543, 544,  
 548, 567, 590, 596, 597, 598, 617, 621, 624, 629, 634, 635, 651, 659,  
 660, 677, 689, 691, 701, 712, 714, 717, 718, 719, 720, 721, 722, 723,  
 726, 727, 729, 732, 733, 734, 735, 736, 737, 739, 740, 741, 742, 743,  
 744, 745, 746, 747, 749, 750, 751, 752, 753, 754, 755, 777, 778, 779,  
 780, 781, 783, 784, 785, 786, 788, 790, 791, 792, 793, 794, 795, 796,  
 798, 799, 800, 801, 802, 803, 815, 821, 822, 829, 835, 836, 859, 861,  
 862, 863, 864, 865, 866, 867, 880, 881, 882, 911, 912, 913, 944, 945,  
 973, 974, 976, 978, 1028, 1030, 1057, 1073, 1093, 1104, 1123, 1133,  
 1140, 1141, 1157, 1161, 1162, 1164, 1171, 1172, 1178, 1183, 1200,  
 1205, 1206, 1207, 1217, 1218, 1232, 1243, 1248, 1249, 1250.

B. Design Considerations (cont)

3. Technologies (cont):

b) Aerostatics:

60, 145, 149, 239, 337, 349, 399, 420, 421, 425, 507, 516, 540, 605,  
724, 900, 937, 964, 1081, 1186, 1219, 1227, 1228.



B. Design Considerations (cont)3. Technologies (cont):c) Structural/Materials:

8, 12, 25, 30, 34, 35, 36, 37, 63, 65, 89, 90, 91, 92, 93, 95, 96, 97,  
98, 99, 100, 102, 103, 104, 105, 106, 107, 109, 110, 111, 112, 113, 119,  
121, 136, 137, 140, 141, 151, 154, 155, 156, 160, 161, 162, 164, 172,  
174, 176, 177, 178, 181, 182, 184, 186, 187, 188, 189, 195, 197, 198,  
204, 205, 210, 211, 216, 217, 219, 220, 221, 222, 224, 225, 226, 227,  
228, 230, 231, 232, 234, 235, 236, 237, 238, 241, 242, 244, 245, 247,  
248, 249, 250, 252, 253, 254, 255, 256, 257, 264, 265, 273, 274, 278,  
285, 289, 290, 293, 294, 296, 297, 298, 300, 303, 306, 307, 308, 309,  
312, 316, 317, 322, 323, 325, 328, 329, 330, 331, 334, 335, 336, 340,  
342, 344, 346, 350, 352, 353, 360, 361, 362, 369, 375, 380, 386, 392,  
393, 394, 401, 402, 407, 410, 412, 415, 417, 427, 440, 445, 453, 454,  
465, 466, 472, 476, 477, 481, 487, 488, 497, 518, 521, 522, 526, 534,  
539, 541, 564, 570, 577, 580, 582, 583, 584, 586, 592, 612, 613, 626,  
646, 647, 648, 650, 656, 657, 661, 664, 665, 666, 667, 668, 669, 670,  
671, 672, 673, 674, 678, 679, 681, 683, 684, 685, 686, 687, 688, 689,  
690, 692, 694, 695, 696, 697, 700, 703, 705, 711, 715, 716, 739, 752,  
755, 757, 766, 771, 774, 778, 786, 799, 801, 805, 806, 828, 827, 840,  
852, 857, 881, 882, 888, 892, 901, 902, 911, 922, 923, 939, 977, 981,  
1027, 1031, 1037, 1038, 1039, 1047, 1049, 1077, 1096, 1100, 1103, 1105,  
1110, 1111, 1119, 1122, 1138, 1139, 1148, 1154, 1165, 1666, 1167, 1173,  
1174, 1187, 1188, 1191, 1192, 1193, 1194, 1195, 1199, 1214, 1243, 1251,  
1252, 1255.

B. Design Considerations (cont)

3. Technologies (cont):

d) Propulsion:

1, 9, 30, 55, 71, 114, 125, 145, 148, 149, 183, 192, 194, 196, 203,  
208, 209, 229, 233, 243, 260, 268, 288, 320, 368, 378, 384, 388, 418,  
419, 424, 464, 474, 479, 486, 578, 613, 621, 623, 625, 626, 631, 675,  
679, 711, 714, 763, 803, 846, 859, 879, 887, 888, 892, 910, 920, 931,  
933, 945, 957, 966, 985, 1040, 1041, 1070, 1156, 1184, 1209.

B. Design Considerations (cont):

3. Technologies (cont):

e) General:

18, 22, 26, 27, 30, 47, 48, 49, 74, 101, 117, 171, 175, 180, 185, 191,  
240, 277, 281, 286, 313, 326, 339, 357, 367, 389, 429, 430, 448, 457,  
491, 493, 494, 496, 509, 510, 511, 529, 530, 539, 541, 568, 569, 572,  
576, 604, 606, 608, 609, 614, 630, 633, 811, 824, 825, 859, 882, 892,  
901, 927, 928, 938, 943, 1020, 1039, 1061, 1074, 1092, 1097, 1101,  
1109, 1117, 1124, 1126, 1148, 1149, 1202, 1203, 1221, 1224, 1225,  
1226, 1235, 1242.

B. Design Considerations (cont):

3. Technologies (cont):

f) Stability and Control:

2, 14, 30, 54, 56, 57, 60, 116, 118, 123, 138, 153, 169, 179, 186, 213,  
 215, 216, 223, 243, 246, 271, 275, 279, 283, 285, 292, 293, 337, 343,  
 345, 349, 382, 383, 389, 403, 404, 423, 443, 456, 467, 473, 475, 482,  
 490, 492, 500, 502, 519, 520, 538, 543, 544, 545, 546, 549, 558, 559,  
 560, 561, 582, 591, 596, 597, 614, 622, 624, 627, 646, 691, 698, 699,  
 704, 720, 726, 729, 731, 733, 735, 736, 737, 739, 740, 741, 742, 743,  
 744, 745, 746, 747, 749, 750, 751, 752, 753, 755, 757, 758, 760, 761,  
 768, 770, 773, 775, 777, 778, 780, 781, 785, 786, 788, 791, 792, 793,  
 795, 801, 815, 839, 852, 868, 903, 925, 929, 930, 940, 953, 975, 976,  
 978, 983, 988, 989, 999, 1000, 1022, 1028, 1040, 1041, 1051, 1055,  
 1056, 1062, 1063, 1065, 1075, 1094, 1095, 1133, 1155, 1157, 1159,  
 1164, 1183, 1231, 1233, 1247.

B. Design Considerations (cont):

3. Technologies (cont):

g) Human Factors:

517, 943, 980, 1017, 1069.

B. Design Considerations (cont):

3. Technologies (cont):

h) Support Equipment:

1, 28, 44, 46, 53, 58, 115, 152, 167, 168, 169, 189, 190, 197, 258, 282,  
382, 428, 458, 459, 475, 616, 654, 655, 680, 717, 723, 804, 828, 862,  
985, 993, 994, 999, 1010, 1049, 1096, 1098, 1106, 1107, 1108, 1153,  
1223.

B. Design Considerations (cont):

3. Technologies (cont):

1) Manufacturing:

891, 892, 936, 1080.

B. Design Considerations (cont):

4. Performance Estimates:

6, 43, 143, 146, 173, 193, 259, 266, 280, 301, 319, 324, 333, 339, 348, 351,  
354, 373, 377, 381, 406, 433, 435, 436, 437, 439, 440, 446, 449, 450, 451,  
452, 460, 478, 480, 610, 611, 623, 628, 682, 706, 978, 1015, 1143, 1160,  
1161, 1168.



C. Fabrication:

1. Past:

51, 286, 526, 641, 642, 1080, 1214.

C. Fabrication (cont):

2. Present/Future:

51, 1080.

D. Test and Evaluation:

1. Ground:

3, 8, 9, 10, 484, 581, 662, 675, 676, 677, 678, 680, 684, 707, 814, 1010,  
1253, 1254.

D. Test and Evaluation (cont):

2. Flight:

3, 8, 9, 10, 487, 506, 514, 556, 557, 581, 582, 662, 676, 677, 678, 680,  
701, 814, 1002, 1003, 1005.

E. Acceptance Tests:

581, 662, 675, 676, 677, 678, 679, 707, 712, 814.

F. Operation:

1. Flight Handbooks/Procedures:

78, 85, 86, 122, 878, 884, 885, 984, 985, 990, 1006, 1042.

F. Operation (cont):

2. Evaluations:

a) Vehicle:

38, 118, 119, 126, 131, 139, 142, 147, 150, 157, 160, 161, 162, 163,  
165, 166, 167, 170, 176, 177, 178, 193, 199, 200, 206, 212, 214, 218,  
220, 275, 304, 305, 321, 407, 415, 483, 487, 556, 557, 561, 607, 622,  
623, 682, 685, 686, 687, 701, 705, 706, 751, 784, 807, 834, 903, 949,  
981, 982, 983, 988, 989, 996, 997, 998, 1001, 1002, 1003, 1005, 1010,  
1014, 1015, 1022, 1043, 1159, 1216.

F. Operation (cont):

2. Evaluation (cont):

b) Sensor:

29, 61, 547, 566, 585, 589, 656, 658, 687, 698, 699, 702, 707, 709,  
718, 780, 823, 845, 942, 949, 979, 987, 995, 997, 1007, 1008, 1009,  
1011, 1012, 1013, 1113, 1114.



F. Operation (cont):

2. Evaluation (cont):

c) Weapons:

61, 79, 639, 676, 681, 996.

F. Operation (cont):

2. Evaluation (cont):

d) Fleet Exercises:

851, 991, 992, 1004, 1007, 1086, 1132.

F. Operation (cont):

2. Evaluation (cont):

e) Support Equipment:

593, 985, 994, 1010, 1153.

F. Operation (cont):

3. Mission Performance:

a) ASW:

547, 595, 615, 710, 713, 808, 809, 810, 823, 851, 921, 942, 1007,

1012, 1013, 1014.

F. Operation (cont):

3. Mission Performance (cont):

b) AEW:

644, 649, 653, 693, 713, 851, 949.

F. Operation (cont):

3. Mission Performance (cont):

c) Other:

332, 333, 832.

F. Operation (cont):

4. Ground Handling:

44, 77, 83, 115, 118, 152, 165, 168, 170, 189, 190, 197, 201, 258, 282,  
434, 442, 484, 513, 537, 654, 655, 717, 723, 828, 883, 929, 930, 962, 993,  
1010, 1049, 1087, 1096, 1098, 1106, 1107, 1108, 1123, 1197, 1200, 1212,  
1213.

F. Operation (cont):

5. Vulnerability:

a) Weather:

756, 759, 764, 834.



F. Operation (cont):

5. Vulnerability (cont):

b) Hostile Action:

426, 469, 639.

F. Operation (cont):

6. History:

11, 39, 42, 50, 51, 59, 62, 68, 70, 87, 88, 287, 369, 429, 489, 493, 501,  
509, 527, 553, 554, 555, 563, 565, 571, 573, 588, 607, 618, 641, 812, 817,  
824, 825, 830, 837, 838, 846, 847, 848, 849, 950, 851, 853, 855, 856, 858,  
904, 905, 906, 909, 919, 928, 958, 959, 960, 961, 963, 985, 991, 992, 1001,  
1004, 1018, 1020, 1025, 1050, 1074, 1078, 1079, 1082, 1085, 1088, 1089,  
1090, 1091, 1121, 1132, 1134, 1135, 1142, 1144, 1145, 1146, 1147, 1156,  
1158, 1163, 1170, 1189, 1198, 1201, 1208, 1215, 1222, 1246.

F. Operation (cont):

7. Environmental Data/Considerations:

45, 207, 311, 387, 654, 725, 756, 759, 762, 764, 776, 789, 807, 841, 901,  
924, 1060, 1066, 1067, 1072, 1122, 1169, 1236.

G. Costing:

15, 32, 462, 505, 603, 638, 640, 716, 831, 853, 1086, 1128, 1131.

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